81093987

METHOD AND SYSTEM FOR CONTROLLING AN INTERNAL COMBUSTION ENGINE HAVING A BRAKE BOOSTER

Field of Invention

The invention relates to a method for controlling an internal combustion engine, in particular an internal combustion engine with direct injection and spark ignition, during warmup of an exhaust gas treatment device connected to the internal combustion engine.

Furthermore, the invention relates to an engine control system for an internal combustion engine which is designed to carry out such a method, and a brake booster which can be used within the scope of the method.

Background of the Invention

Brake boosters reduce the force which is applied by the driver to brake a motor vehicle. An embodiment of a brake booster has a movable working piston between a low pressure chamber and a high pressure chamber. A pressure difference between the chambers exerts a force on the piston to aid braking. The vacuum for the low pressure chamber is usually generated by coupling to the intake manifold of the internal combustion engine, while ambient pressure is applied to the high pressure chamber. The brake booster therefore relies on sufficient vacuum in the intake manifold.

Furthermore, it is known that engines with direct injection and spark ignition (DISI) permit considerably faster warm up, and thus activation of a catalytic converter arranged in the exhaust gas path, in comparison with port fuel injected engines with injection in the intake port. The control strategy commonly used retards spark timing to maximize the flow of heat into the exhaust gas. To maintain the desired engine speed , the throttle valve of the internal combustion engine is opened further to supply a larger quantity of air to the engine. This can lead to anabsolute pressure in the intake manifold reaching approximately 80 kPa, is a low vacuum.). The pressure difference between ambient pressure (approximately

100 kPa at sea level) on the high pressure side and a low vacuum, e.g., 80kPa does not ensure reliable function of the vacuum brake booster.

Summary of the Invention

A method for controlling an internal combustion engine to maintain pressure in a brake booster during warmup of an exhaust gas treatment device coupled to the internal combustion engine is disclosed. The brake booster is coupled to an intake of the internal combustion engine and actuated by a reduced pressure in the intake The method includes monitoring pressure in the brake booster and decreasing pressure in the engine intake when the pressure in the brake booster is greater than a threshold pressure.

The threshold pressure is a pressure above which an operational capability of the brake booster is less than desired.

The method further includes reducing an amount of spark retard to bring brake booster pressure below the threshold. The method further includes increasing engine rotational speed to bring brake booster pressure below the threshold.

An advantage of the present invention is that brake booster operation is ensured. Furthermore, warmup of the catalytic converter is resumed as soon after startup as possible.

A further advantage is that brake booster vacuum is maintained via increasing engine speed and/or advancing spark advance timing, both measures being readily controlled by the engine control system.

Brief Description of Drawings

The invention is explained in more detail below with the aid of drawings by way of example. In the drawings:

Figure 1 is a schematic view of the components for carrying out a method according to the invention;

Figure 2 is a schematic flowchart of a control strategy according to an aspect of the present invention;

Figure 3 is a time line of various engine parameters showing operation according to the present invention.

Detailed Description

The internal combustion engine 9 illustrated in figure 1 is preferably a petrol engine with direct injection and spark ignition. The internal combustion engine 9 is supplied with air via an intake manifold 8. Exhaust gases leave the internal combustion engine 9 via an exhaust gas manifold and an exhaust gas pipe with a catalytic converter (not shown) disposed therein. Operation of engine 9 is controlled by an engine controller 10 which may be implemented, for example, as a microprocessor and receives various items of sensory information of the motor vehicle and of engine 9, and outputs control signals to engine 9 and other components of the motor vehicle.

Furthermore, Figure 1 is a schematic illustration of a brake booster 1. The brake booster 1 contains a working piston 4 which is movably arranged between a low pressure chamber 2 and a high pressure chamber 3. The working piston 4 is connected to the brake pedal 6 via a piston rod. Due to a vacuum in the low pressure chamber 2 and a comparatively higher pressure in the high pressure chamber 3, a force is exterted on piston 4 which generates the braking pressure. The vacuum in the low pressure chamber 2 is generally obtained from the intake manifold 8 of the internal combustion engine 9 via a one-way valve 5, while the high pressure in the high pressure chamber 2 typically corresponds to ambient pressure.

Reliable function of the brake booster 1 requires a sufficient difference in pressure across the working piston 4, which in turn requires sufficient vacuum in the intake manifold 8. However, a sufficient vacuum in the intake manifold 8 is not ensured when a cold start of the internal combustion engine 9 occurs in engines with direct injection and spark ignition., Typically, spark retard is used to achieve more rapid warming of the catalytic converter. To ensure a sufficient engine speed of the internal combustion engine 9, the throttle is opened and absolute pressures

in the intake manifold of 80 kPa result. However, 80kPa is not sufficient vacuum for reliably operating the brake booster 1.

According to the invention, the pressure state of the brake booster 1 is therefore monitored. This is preferably carried out by an absolute pressure sensor 7a which is arranged in the low pressure chamber 2 to measure the pressure, pl, present there and to communicate it to the engine controller 10. The engine controller 10 can therefore detect an insufficient partial vacuum and correspondingly actuate the internal combustion engine 9 in such a way that the vacuum in the intake manifold 8 is sufficient. If, for example, pressure, pl, in the low pressure chamber 2 lies above a predefined absolute pressure of, for example, 60 kPa at sea level at the start of the warming-up phase of the internal combustion engine 9, the engine controller 10 can increase the maximum engine speed after starting up occurs and before the idling state to generate a lower absolute pressure in the intake manifold 8 after the initial overshooting of the engine speed, and to achieve the desired vacuum in the brake booster 1. The degree of overshooting of the engine speed preferably depends on the pressure in the low pressure chamber 2 when engine 9 starts, i.e. the higher the pl, the greater the overshoot of the engine speed, and vice versa.

If the increase in the engine speed overshoot, at the changeover into the idling mode, is unable to bring about a sufficient vacuum in the brake booster 1, the strategy for more rapidly warming up the catalytic converter is discontinued by the engine controller 10 until the desired vacuum in the brake booster 1 is reached. This leads to a normal idling mode of engine 9 in which the desired low absolute pressure in the intake manifold 8 of 40 kPa, for example, is brought about more quickly.

If the pressure state of the brake booster 1 is sensed only by pressure sensor 7a in the low pressure chamber 2 the pressure of the high pressure chamber 3 is presumed to be virtually constant, i.e. average atmospheric pressure. To improve the precision of the system and to ensure reliable functioning even at a high altitude above sea level (i.e., at a relatively low ambient pressure), the pressure in the high pressure chamber 3 is taken into account. This can be carried out, as illustrated in Figure 1, by a second pressure sensor 7b arranged in the high pressure chamber 3, which communicates the pressure to the

engine controller 10. Alternatively, the engine controller 10 can also measure the ambient pressure as this variable is frequently already determined for other purposes of engine control. Alternatively, the pressure difference between the high pressure chamber 3 and the low pressure chamber 2 can be sensed directly by a differential pressure sensor (not shown, as ultimately only pressure difference is significant for determining proper function of the brake booster 1.

Figure 2 shows the sequence of a method according to the invention in yet more detail. After the engine is started in step 12, it is checked in step 14, after the a certain delay (not shown) by which time the pressure in the intake manifold is nearly steady state, whether the pressure in the brake booster, p_brake, lies below a predefined threshold value (for example 40 kPa absolute. If this criterion is fulfilled, a normal idling mode with a desired maximum engine speed of des_engine_speed is initiated, which corresponds to a maximum engine speed nom_engine_speed (for example 1300 rpm), (step 16). Otherwise, after startup, the desired maximum engine speed is increased in step 18 as follows:

des_engine_speed = nom_engine_speed + (speed_add * (p_brake / threshold –1))

The factor speed_add is a normalization factor, for example 200 rpm.

If the pressure in the brake booster exceeds a second threshold (for example, 50 kPa absolute) in step 20, the forced warm up for the exhaust gas treatment arrangement is reduced or eliminated in step 22 until the corresponding second threshold value has been reached. The sub-routine is then terminated.

Figure 3 illustrates a timeline of engine parameters. This is a NEDC test cycle at 20°C, which is used to measure pollutant emission over a predefined engine speed/load schedule. Curve 30 shows the pressure profile in the intake manifold. In a forced warm up of the catalytic converter, manifold vacuum reaches, according to the prior art, 10 kPa, which is insufficient to reliably operate a brake booster. Brake booster vacuum (32) correspondingly remains low. When the brakes are not actuated, brake booster vacuum assumes approximately the maximum intake manifold vacuum due to the check valve present between the intake manifold and the brake booster.

According to the invention, intake manifold vacuum is reduced to approximately 60 kPa (34), several seconds after startup as a result of diminishing

or eliminating measures undertaken to rapidly warm up the exhaust treatment device. Consequently, brake booster vacuum is at a higher level 36, thereby ensuring reliable operation of the brake booster (curves 34 and 36 at later times not shown).

We claim: